

Claims

1. Luminescence-conversion LED, an LED chip emitting
primary radiation with a peak wavelength in the
5 range of 300 to 470 nm, this radiation being
converted partly or completely into secondary
longer-wave radiation by photoluminescence by at
least one phosphor which is exposed to the primary
radiation of the LED, characterized in that the
10 conversion is achieved at least with the assistance
of a phosphor of a mean particle size d50 that lies
in the range of 1 to 50 nm, preferably 2 to 25 nm,
which is referred to hereafter as a nanophosphor.
- 15 2. The LED as claimed in claim 1, characterized in
that the phosphor is dispersed in an encapsulating
compound which is exposed to the primary radiation,
the encapsulating compound consisting of insulating
material.
- 20 3. The LED as claimed in claim 1, characterized in
that a blue emitting primary radiation of a peak
wavelength of 420 to 470 nm is used, together with
a secondary yellow emitting phosphor.
- 25 4. The LED as claimed in claim 1, characterized in
that a UV emitting primary radiation of a peak
wavelength of 330 to 410 nm is used, together with
three secondary red, green and blue emitting
30 phosphors.
5. The LED as claimed in claim 4, characterized in
that the following phosphor system is used: for
red: Y2O2S:Eu; and for green: ZnS: Cu,Al or
35 ZnS:Cu,Mn or ZnS:Cu; and for blue SCAP or ZnS:Ag.
6. The LED as claimed in claim 1, characterized in
that the phosphor is chosen such that it has only
low absorption in the range of the peak wavelength

of the primary radiation and is in particular a phosphor that is made to luminesce by an activator.

7. The LED as claimed in claim 6, characterized in
5 that a nanophosphor is chosen such that an identical, but coarser-grained phosphor, which is referred to hereafter as a μm phosphor, exhibits at the peak wavelength of the LED chip a reflection of greater than 50% when a reflection measurement is
10 carried out on a pressed powder tablet which consists of the μm phosphor and which is optically dense, that is to say has an angle-integrated transmission of $< 5\%$, coarse-grained meaning that the mean particle size d50 is greater than $1\ \mu\text{m}$, in
15 particular d50 is $\leq 20\ \mu\text{m}$, preferably d50 is $\leq 10\ \mu\text{m}$.
8. The LED as claimed in claim 6, characterized in
20 that the long-wave absorption edge of the nanophosphor, which is described by the point A50, lies under the long-wave edge of the primary emission, described by the long-wave point FW 90, preferably FW 70, particularly preferably by FW 50, extremely preferably by the peak wavelength itself.
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9. The LED as claimed in claim 7, characterized in
30 that a nanophosphor with an activator is used, chosen such that the concentration of the activator is low, to be precise reaches at most 75%, preferably 10 to 50%, of the concentration of the activator in the case of the identical μm phosphor, so that the given activator concentration of the μm phosphor is higher and serves as a reference
35 corresponding to 100%, the μm phosphor being chosen such that it has high absorption in the range of the peak wavelength of the primary radiation, preferably more than 50%, in particular more than 70%, but an identical phosphor with low concentration of the activator has low absorption

in the range of the peak wavelength of the primary radiation, preferably at most 30%, in particular at most 20%.

- 5 10. The LED as claimed in claim 1, characterized in that a single phosphor is used, comprising semiconducting nanoparticles, in particular CdSe.
- 10 11. The LED as claimed in claim 1, characterized in that the chip can be connected to a voltage source via electrically conductive terminals.
- 15 12. The LED as claimed in claim 11, characterized in that the voltage source provides a voltage of at most 5 V.
- 20 13. The LED as claimed in claim 9, characterized in that the nanophosphor is a garnet A₃B₅O₁₂ which is doped with a rare earth element D, the proportion of D being at most 0.9 mol % of A.
- 25 14. The production of LEDs with nanophosphors as claimed in one of the preceding claims, the phosphor being applied directly to the chip by means of CVR or CVD.
- 30 15. The production of LEDs with nanophosphors as claimed in one of the preceding claims, the phosphor being applied to the chip by means of printing, spraying or ink-jet.
- 35 16. The use of nanophosphors with a mean particle size d₅₀ of 1 to 50 nm as a conversion means in optical semiconductor devices of the LUCOLED type for the conversion of short-wave primary emitting radiation between 300 and 470 nm into longer-wave radiation, in particular into visible radiation in the range of 430 to 750 nm.